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Abstract

Knowledge creation is of high importance for organizations that are characterized with knowledge-intense work to reach and sustain organizational advantage. However, sharing and managing codified, externalized knowledge for further development within groups has shown to be cumbersome and challenging. Within this proposition paper we suggest a model based on the seeding – evolutionary growth – reseeding model which is adapted for collaborative work settingsand describes the development of knowledge assets. We argue that knowledge management can benefit and further increase team performance when the appropriate time formanagement intervention can be predicted. For this purpose parameters,determining the development of explicated knowledge, need to be applied so that knowledge artifacts but also reoccurring collaboration processes ready for combination can be detected. By combining existing knowledge assets new knowledge can be created which can be “re”-seeded within the same or another similar collaborative setting.

1 Introduction

For some time now, organizations have recognized knowledge as a primary resource for producing goods and services, which enables an organization, when managed accordingly, to increase effectiveness, efficiency, and competitiveness [42]. Consequently, the appropriate handling of knowledge within organizations is in the focus of knowledge management initiatives that strive to improve organizational effectiveness as well as to create and sustain superior competitive positions[22]. Processes of knowledge creation after [29] comprising internalization, externalization, socialization, and combination, are under focus of this paper, since knowledge creation seems to impact innovation and hence competitive advantage[17]. In this regard, organizations are challenged with the ability to effectively apply existing knowledge to create and apply new knowledge[1]. Knowledgecreation is primarily performed in collaborative settings and consequently studying knowledgecreation on a group level seems very promising[44].

Usually, employees have a comprehensive base of information and knowledge available that they can draw upon [4]. However, they are challenged with the decision which kind of codified knowledge is important and needs attention [33].

Appropriate management interventions can facilitate knowledge development [17]by combining stacks of existing codified knowledge, developed by groups, into a set of consolidated, qualified and reusable knowledge assets. These can subsequently be fed back to the same or a similar group. Knowledge assetsare understood as explicated knowledge in documents, manuals, images, routines, etc. [46]. We understand collaborative knowledge creation as a seeding – evolutionary growth – reseeding (SER) [6]process which is basically problematic to manage, since groups are typically self-organized [13]. However, when parameters can represent the evolution of knowledge assets, they can be used to determine when these assetsaremature for consolidation and (re)combination. The goal of this paper is to propose a model which supports the management of collaborative knowledge creation and to identify the future research avenues.

The paper is structured as followed. Section 2 will introduce the basic ideas related to knowledge creation, collaboration and the management of organizational knowledge by providing analogously a short review of the literature. The subsequent Section 3 introduces the SER model adapted for collaborative settings with an application scenario. Section 4 points to managerial and technical challenges that come along with a potential implementation. Section 5 will conclude this paper and gives an outlook.

2 Related work

Knowledge creation is highly complex, organization-specific, and highly tacit, has a causally ambiguous nature and is usually performed in collaborative settings [3, 19, 44]. The collaborative knowledge creation is not necessarily performed linear and is instead performed by cycles of creation and maintenance [34]. Hence, the process of knowledge creation itself is difficult to measure and to manage[3, 19, 27, 44]. The output of this process, i.e. the created knowledge, can be investigated. The output of such processes are knowledge assets comprising product specifications or prototypes which represents the realization of a new idea [27, 28]. The goal should be to influence the black box of knowledge creation during collaboration by analyzing the output and adapting the input.

In the following we will outline the basic existing research approaches that follow our approach. First, the evolution of knowledge as well as knowledge creation processes will be introduced. Then, knowledge creation in collaborative settings will be outlined and challenges highlighted. Finally, issues for knowledge management will conclude this section.

2.1 The creation and development of knowledge

In analogy to the evolution known from biology, knowledge is also subject of growth, development and maturing [20]. Several models in literature can be found which describe maturing of people, e.g. competencies, of objects, i.e. documents or services or of social systems, e.g. communities or processes [14]. In this regard, maturing of knowledge is related to an increase of its value [11]. Hence, the process of knowledge maturing seems interesting to receive management attention.

As in Darwin's theory of evolution, a process of variety-generation, i.e. recombination of knowledge and selection, can be found in knowledge development processes [20]. In this regard, the generation of new variants is performed in a continuous process of knowledge creation [30]. The selection of these variants is supported by the organization and is guided by organizational goals and requirements [20]. Knowledge which fits best to (changed) organizational settings [28], which is on a higher level of maturity [24] or which promises new innovations [20] can be selected. After selection, knowledge has to be shared so that the organization is able to translate it into a competitive advantage [5]. In this regard, an evolutionary development of the knowledge can be assumed and thus a cycle originates.

2.2 Knowledge in collaborative settings

The term collaboration is used throughout literature and practice in many contexts and can be associated with a number of meanings. In this paper we adopt [15]'s understanding who envision collaboration as a process or a system. When understanding collaboration as a process, it exists of a sequence of actions that are performed by a group to achieve a common goal. Collaboration understood as a system, relates to a group, interaction purposefully, possibly supported by collaboration technology in (a)synchronous settings [15].Since individuals possess specialized knowledge, organizations have interest in generating new or combing existing knowledge by putting people together to obtain competitive advantage [8]. [29] differentiate between four knowledge levels comprising individual, group, organizational knowledge and inter-organizational knowledge [29]. While encoding, organizing, and recalling of knowledge occurs within an individual's mind, the use and exchange of shared knowledge elements is a collective process. In this regard, individuals can gather new knowledge or restructure their mental models of existing knowledge collaboratively from the environment initiated by unforeseen triggers. Here, collective processes are typically self-organized and groups regulate and organize their knowledge creation processes by themselves[13]. Typically five underlying processes comprising, (1) initiation – starting with a knowledge seed, (2) crystallization – adding context, (3) sharing – distributingin community, (4) qualification – validating new knowledge, and (5) combination – refining, excluding, sorting and categorizing new knowledge, which results in knowledge creation [17]. With respect to KM, organizations strive to combine explicit knowledge into more complex sets of explicit knowledge, since these processes facilitate innovation. It has been shown, that the integration of distributed knowledge, referring to the combination of knowledge, appears to have the most effect on organizational knowledge [39]. However, the reuse of codified knowledge is often challenging due to team members that fail to share and integrate valuable knowledge [29] or due to appropriate contextualization [37].Group interaction supported by social media, e.g., social-tagging, wikis, weblogs, provide means to facilitate the exchange and creation of knowledge [1, 13].

Summarizing, collaboration enables knowledge creation on the collective levelas well as individual learning. Since groups organize their processes by themselves in a flexible way, appropriate support from a management perspective appears to be challenging. A variety of ICT in general or social media in particular can be provided to support the collaboration and hence the creation of knowledge. However, organizations struggle with the purposeful combination of codified knowledge that was generated in such processes.

2.3 Management of organizational knowledge

The effective management of knowledge has emerged as a critical source of organizations competitive advantage [5]. In this regard, knowledge can be considered as production factor or even as key production factor for many businesses [8, 21]. However, in contrast to traditional production factors, such as raw materials or machines, knowledge has some characteristics which make the management more difficult. Knowledge is hard to identify, and even more difficult to value and deploy [5]. Knowledge depends on human beings and their actions and it is difficult to codify [28]. Furthermore, knowledge highly depends on its social context of its creation and absorption [21]. Hence, unlike data or information, knowledge cannot easily be transferred or distributed, resulting in high costs for knowledge transfer [36]. Due to the fact that more knowledge is not always better, the determination of the right quantity of knowledge and the right piece of knowledge is challenging [38].

Considering these characteristics of knowledge, its management has to ensure that the right knowledge is available in the right form, in the right quantity, to the right processor, at the right time, and to reasonable cost [12]. From a strategic point of view, knowledge management in organizations can be implemented by primarily using the personalization strategy, i.e. supporting the communication between experts, or by primarily using the codification strategy, i.e. focusing on documentation and sharing of codified knowledge [10]. However, organizations cannot neglect one stream and thus a 80:20 mix of both strategies is usual [10]. The first strategy relies on the idea that the organizational knowledge is the sum of the knowledge hold by employees [40]. Hence, knowledge can be selected by choosing employees and bringing them together or by establishing communication channels among them. The second strategy relies on the idea of the organizational memory, in which the codified organizational knowledge can be stored [16]. Needed knowledge can be selected from internal sources, i.e. the organizational memory and it can be made suitable for subsequent use[12]. Suitable in this regard means to prepare the selected knowledge taking the context of receivers into account and to deliver the knowledge adaptively. In the following the second stream, e.g. the codification strategy should be of primary focus and knowledge management comprises guidance, development and usage of the organizational knowledge base to achieve the organizational goals [31].

The main primer of knowledge creation is the individual knowledge worker interacting in a socio-technical environment [28]. However, knowledgecreation is primarily performed in collaborative settings and consequently studying it in collaborative settings seems very promising[44]. In the following an approach for the management of these knowledge creation processes is proposed. The main aim is to provide a framework guiding these processes and aligning them to organizational goals.

3 An approach for the management of knowledge creation

The theoretical framework is based on the concept of seeding, evolutionary growth and reseedingintroduced by [6]and adapted for the management of knowledge creation and development in collaborative settings. As stated in the former section, there is a need to consolidate and combine stacks of codified knowledge created in collaborative settings. The basic problem in this regard is, that the appropriate time of intervention is dependent on the collaboration process and might vary with respect to tasks and people involved.

With the appropriate monitoring of the outputsoriginating from a knowledge creation process, e.g. a knowledge element reaches a specific threshold of maturity, a time of intervention can be determined. For this purpose the following section will first introduce the SER-model adapted for collaborative settings and is followed by anexemplary application scenario.

3.1 Seeding – Evolutionary growth and Reseeding model

The SER-model is an evolutionary model where in its seeding phase domain expert, initializes the process with existing domain knowledge. In the following evolutionary growth phase, users modify assets as they use them until there is a need for reorganization. In the last process, reseeding, contextualized information will be reformulated so that it is suitable for new or changed requirements [6]. The process is described in the following and visualized in Figure 1.

Seeding

Due to the fact that knowledge creation builds on prior knowledge, a basis for this development is needed. Hence, firstly it needs to be decided which ideas should be included [34]. Preferably, a domain expert provides a set of knowledge assets and IT infrastructureto initiate the knowledge creation process. The seeding set is important for the future creation and development of knowledge, because it might influence users' behavior during the following collaborative knowledge creation activities. The seeding knowledge represents the point of departure and defines the start points of the collaborative knowledge creation paths. By defining the initial set, the organization is able to influence some characteristics of the collaboration process and the created artifacts[26]. Summing up, the seeding phase is a management phase in which the input of the knowledge development is defined.

Evolutionary growth

In the evolutionary growth phase, the collective cooperates, communicates and coordinates to reach their common goal. The community refines the initial ideas and accommodate to the multiple perspectives of the community members and their ideas [34]. Through externalization processes, new or developed knowledge gets captured within explicated knowledge assets, i.e., documents, and is subsequently stored and shared within the group. At some point however, variants of knowledge, i.e. results of the collaborative knowledge creation, become apparent and (1)a combinationand consolidation of the created knowledge is required to ensure further successful collaborationas well as (2) gardening and selecting developed knowledge seems promising. Gardening in this context describes the organizational activity to transfer valuable, newly combined, knowledge assets, into some form of organizational knowledge so that it can be reused by others without losing its context. Hence, gardening facilitates the detection of relevant explicated knowledge so that it can be secured, distributed and transferred to other knowledge workers.Furthermore, it can be beneficial to consolidate and combine the created knowledge to react on changed requirements or to introduce new knowledge in order to stimulate further development. The knowledge creation is performed in a collaborative black box process. However, the determination of the right moment to switch to the reseeding phase is challenging. This determination requires an investigation of the outcomes by monitoring observable or better automatically discoverable parameters of the evolutionary growth phase.

Reseeding

After a need for reorganization, stimulation or gardening, was detected the *reseeding phase* is performed by domain experts. Modified as well as newly created knowledge assets are screened

and in case of a useful contribution they are selected and added to the organizational knowledge base. These knowledge elements can replace older versions or they can be added as adapted version, i.e. prepared for a specific target group. Apart from gardening and using created knowledge for other purposes, the further development of the underlying collaboration process is in the main focus. Supposed insufficient knowledge assets are excluded from the seed to make it more clearly arranged. Furthermore, new knowledge elements can be added to stimulate the development in a certain direction. Especially this activity can be used to guide and facilitate the knowledge development in organizations. Finally, the modified set of knowledge elements is used as input for the seeding process.

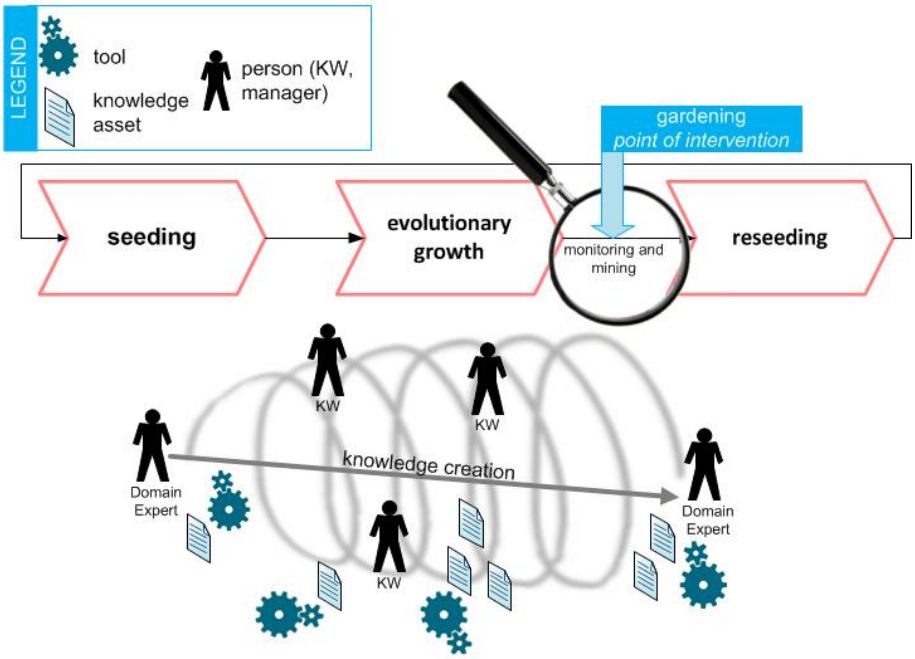

Figure 1: SER model for managing knowledge creation in collaborative settings

3.2 A scenario

The following scenario will describe a collaboration problem and how the proposed model can support effective management of collaborative knowledge creation and development:

The seeding phase

A project manager of a telecommunication agency defines for her project team a new task that aims at proposing new or improved product features. For this purpose she uses on Microsoft SharePoint2010 (SP10) as the collaboration platform and uploads a number of input documents that comprise complaint reports of similar products and uses the list functionality to provide initial features that represent current must-haves. This workspace on SP10 is also connected to her Microsoft Outlook application from where she invites her project team and creates tasks that are synchronized between the two applications.

The evolutionary growth phase

Based on the information the team has, they start searching for innovative product features by browsing the internet. Work routines emerge that implicitly hold knowledge and only a fraction is externalized to the collaboration platform. For examplethe team finds a number of relevant

information during their search processes which they bookmark. Some team members select the deemed most important ones and store them on SP10. Also weekly meetings are held to update each other on the progress. For each meeting, regardless if it's held face-to-face or virtual, meeting minutes get created from a team member and collected in the repository for meeting management. Documents are collected in SP10 repositories and tagged with the name of the creator and editors, timestamps for creation and latest changes, with the type of the feature, whether it is a technical, a service, or a marketing feature. Some team members use the blog functionality and post news or ideas regarding the current features. For fast communication or immediate problems and open questions also messaging services are used that allow for synchronous collaboration. Over time, ideas of team member's start to converge, they discuss and negotiate further steps and they develop their own solutions. For this purpose, blog posts receive comments and initial lists of features get extended with recommendations how to adapt them to the organization's product line. Steadily the available codified knowledge grows leading to the challenge that KWs are confronted with too much potential resources but lack understanding what is important and needs their attention.

An integrated tracking toolfollows all user interactions of the project team and collects information which kind of knowledge elements are changed or composed from which parts of other knowledge elements. Content-related parameters, such as readability scores or version changing scores track how knowledge elements, i.e., blog posts or documents, develop over time. As soon as a number of parameters exceed a predefined value, the tracking tool notifies the project manager.

The reseeding phase

The tracking tool notified the project manager that a set of knowledge assets require her attention. To ensure that the project team does not lose track of their codified knowledge it is now important to consolidate available knowledge sources. Subsequently, a further cycle of collaboration is initiated and valuable versions of newly created knowledge are stored to the organizational knowledge base.The project manager includes ideas from the blog posts into a list that will be public to the whole organization and hence represents first results of their project. Some other interesting features still lack of description detail and how to adopt them for the organization's product line. Hence, they are used as seed for another cycle.

4 Discussion

Some challenges of the proposed approach for the management of knowledge creation in collaborative settings remain.The first challenge for implementing the proposed approach is the definition of parameters suitable to judge on the (development) status of the created knowledge and on the status of the collaboration processes. To determine the point of intervention in the evolutionary growth phase, suitable parameters should indicate that knowledge assets are ready for gardening or restructuring. Parameters need to be automatically determined to realize a technical solution and support the proposed approach. Due to the fact that the appropriateness of knowledge elements for certain settings (determination of the suitable seed) substantially depends on the characteristics of the setting itself, suitable parameters describing the collaborative setting are required as well. In the following we discuss these two main aspects, parameters for knowledge elements and the collaborative setting, and also propose an agenda for future research.

Several attributes of codified knowledge, e.g., volatility, usage, proficiency, etc. are discussed in the literature, see [11] for example. In the case of knowledge elements these attributes are represented by meta data which are needed for administration and exchange [26].General and technical metadata elements, like language, author, size or duration can easily be gathered by automatic techniques[2].However, many attributes refer to the context of the knowledge, such as creation and application context or relationships to other knowledge elements. The automatic determination of these important yet complex aspects by attributes seems to be very challenging [33]. Collaborative approaches like collaborative tagging involving users in the annotation and hence in the determination process seem suitable for those attributes that typically need more interpretation, like subject or interactivity level[2].Building on existing standards and specifications for meta data and the existing research on gathering meta data seem promising for the further research.

Metrics to measure the information quality, like readability, information noise, volatility, informativeness[43]or metrics to judge on the quality of articles created by online communities taking the authors reputation [18]or experience [34] into account can be used to identify high quality articles and it seems very promising to apply them for monitoring the knowledge development. The cohesion and coherence of texts, which influences the accessibility of knowledge to different user groups, seem very promising in this regard as well [7]. Metrics investigating the life cycle of WiKi articles can be used to determine the development stage and hence the quality of articles [47]. Due to the fact that quality metrics, cohesion and coherence metrics as well as life cycle metrics can be automatically assessed, one important prerequisite of appropriate parameters is fulfilled. Based on the existing work in quality metrics for text documents the most promising metrics should be selected and applied in real world or experimental settings. This further research and especially the validation and probably the adaptation of proposed metrics to requirements of the proposed approach seem very valuable next steps.

Knowledge can also be manifested in actions and routines and hence representing shared know-how [46]. Approaches such as pattern-based task management [37] offer interesting new research streams how to capture procedural knowledge from daily working procedures. With respect to the definition of developed knowledge, additional research challenges arise that relate to suitable parameters and metrics to assess the point of intervention.

In addition to attributes describing the created knowledge also attributes describing the application context (determination of the seed) or the creation context (determination of reseeding and description of gathered knowledge) of knowledge is required. To ensure effective flow of codified knowledge, there is a need that an individual A shares to some degree the same knowledge base, i.e., tacit knowledge, as individual B, shared meaning and mutual understanding. Hence, an arising issue in this regard is the amount of contextual information necessary for a person or group’s knowledge to be understood by another [1]. This means that a team member might perceive knowledge asset relevant in one context, during one task, but differently in another task. In this regard, six types of dimensionshave been proposed to visualize and categorize knowledge. The dimension comprise (1) time (when?), (2) topic (what?), (3) location (where?), (4) person (who?), (5) process (why?), and (6) type (how?)[23] extended with the concept of technology to describe technical attributes and used for adaptation purposes [25]. A possible approach to implement these dimensions is related to contextualized attention metadata (CAM), which describes computer-related activities by users in an XML format[41].

Core elements comprise e.g., group (who), feed[45], item (how), event (when), session (where), and action (why). This representation context should be standardized [32] which opens up one stream of potential research. Thereexists already a good set of research literature related to thedescription and formal representation of context for implementation purposes, see for example [9, 35, 41]. However, the detection of the current task a worker is involved in is central and is still part of many discourses. The challenge in this regard is the automatic determination of a user's task to improve the understanding of the current situation.

So far we have highlighted that the determination of the start point for the reseeding phase is challenging. Initiating the reseeding phase terminates the evolutionary growth phase conversely and ongoing knowledge creation activities are probably interrupted. These activities can be continued after reseeding, but possible effects should be considered in the decision for starting the reseeding. Due to the fact that the evaluation of such a collaborative setting is very complex and requires an intuitive understanding, this decision should be performed by a human actor. Hence, the monitoring of the set of parameters should result in a notification of the decider by providing further adequate information for decision support. In this regard, an interesting research project relates to the empirical investigation of situations in which a reseeding is considered beneficial.

The aim of the organizational knowledge creation theory is to identify factors impacting on knowledge creation and the development of knowledge [28, 30]. These factors are very valuable starting points for the determination of the seeding and reseeding set. Goal of both sets is the facilitation and the guidance of the collaborative knowledge creation. Influencing and guiding groups by variation of the starting set was researched and shown for collaborative tagging [26]. Tie on this prior research and adapt both streams to the proposed framework is a promising next step.

5 Conclusion

This position paper proposes a management approach to facilitate the organizational knowledge creation in collaborative settings by adapting the SER model. The approach is intended to provide opportunities to guide organizational knowledge creation processes. Furthermore, the gardening of created knowledge and hence the integration into the organizational knowledge base should be facilitated. For an efficient application of the proposed approach an ICT support is considered crucial. In this regard the efficient monitoring of collaborative knowledge creation processes is the most important point. Especially for the determination of the right moment for the reseeding and gardening such a monitoring is mandatory. The monitoring could be realized by parameters indicating the quality of the developing knowledge of knowledge artifacts as well as parameters indicating the status of the collaboration process.

The developments of both groups of indicators are part of future research. However, possible research avenues for the investigation of such indicators in future research were outlined. On the one hand the feasibility and suitability of indicators for knowledge artifacts should be investigated from a technical perspective taking existing technologies into account. On the other hand real world knowledge creation processes could be explored to identify the most meaningful parameters for collaborative knowledge creation processes.

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6 Literature

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